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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

April 19, 1995

Mr. William Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, DC 20554

Reference: ET Docket No. 92-235

Dear Mr. Caton:

Pursuant to §1.1206 of the Commission's rules and regulations, Motorola hereby reports that exparte discussions were held by representatives of Motorola with Herb Zieler and Gene Thompsen of the Wireless Telecommunications Bureau, to discuss comments on the addendum, dated 3/8/95 to the 12.5 kHz and 25kHz masks proposed by Ericsson on February 8, 1995.

Attached is written material used in the discussion.

Regards,

Nick Gorham

Nick Gorham, P.E.
Manager, Spectrum & Standards

Attachment

cc: Commission Participants

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Government Relations
1350 I Street, N.W., Suite 400, Washington, DC 20005-3305 (202) 371-6900 FAX (202) 842-3578

Re: Comments on the Addendum, dated 3/8/95, to the 12.5 kHz and 25 kHz masks proposed by Ericsson on Feb. 8, 1995.

INTRODUCTION and SUMMARY

On March 8, 1995 Motorola made an ex parte filing with the F.C.C. giving a technical analysis of the emission masks proposed by Ericsson on February 8, 1995. Ericsson's addendum letter of March 8 brought out QPSK and TDM measurement methodology issues as well as a modification to the 12.5 kHz channel spacing mask proposed in their original letter of Feb. 6, 1995. In their proposal, page 2, Ericsson states "After questions by the F.C.C. representatives and further review and measurement, a revision to the "skirt" region of the originally recommended mask is proposed. Further, a revision to the current emission spectrum measurement and validation parameters is strongly recommended to achieve much more accurate measurement of the actual emission spectrum."

Ericsson's addendum implies their original mask can be changed to tighten the mask and "further reduce adjacent channel interference". On page 3 of the Ericsson addendum, they proposed to "...use 100 Hz or less resolution bandwidth for measuring spectral emissions (rather than 300 Hz)." In it's March 8, 1995 filing, Motorola provided a technical analysis that demonstrated that a 4.77 dB difference occurs when emissions such as type FIE & GIE are measured using 100 Hz RWB compared to using 300 Hz RWB. This was discussed in the TIA TR 8.1 Measurement Methods committee meeting held on March 14, 1995, and the participants (including Ericsson) agreed that measurement flexibility could be accommodated without allowing additional adjacent channel interference as long as the mask was adjusted for use of a resolution bandwidth (RBW) other than 300 Hz (since the TIA proposed mask was based on the use of 300 Hz RBW and the Ericsson modified mask was based on the use of 100 Hz RBW).

On page 4 of the Ericsson addendum, it was stated that "...Ericsson strongly recommends adopting average detection as an option for measuring spectral emissions" citing the use of "... FFT-based analyzers...". Their recommendation fails to note that there is a 6.5 dB difference in measurement that results when measuring Gaussian noise like emissions between peak and average measurement (ref. - Hewlett Packard Application Note 63C). Like the resolution bandwidth discussion, this difference is liberal in that the use of RMS average display may pass a transmitter tested using the CPH mode.

Motorola is concerned that the Ericsson proposed mask does not provide any consideration of the liberal illusion these 2 measurement method differences produce which will lead to tolerating an increase of interference of 4.77 + 6.53 = 11.3 dB compared to the TIA proposed conservative measurement method. This is 13.5 times more interference power which will lead to degraded service, and lower spectrum utilization in spite of the claim that it offers 2 for 1.

Therefore, Motorola recommends the F.C.C. adopt the adaptive measurement method given on page 13 for the T.I.A. recommended mask. Also, prior to further consideration of the Ericsson proposed mask their data should be resubmitted utilizing the adaptive measurement method.

Our technical analysis follows:

1. Measurement Methods

Masks discussed by Ericsson in their addendum letter of March 8th were treated as if they were on the same basis. They were not due to measurement differences that will be discussed herein.

1.1 Resolution Bandwidth

In its March 1995 filing Motorola provided a technical analysis of the emission masks proposed by Ericsson on February 8, 1995. In that letter, it was stated that a 4.77 dB difference occurs when emissions such as type F1E and G1E are measured using 100 Hz RBW compared to using 300 Hz RBW. That amount was calculated by using $10\log_{10}(300/RBW)$, where RBW is the resolution bandwidth in Hz. Further, this difference results in an illusionary interference protection margin as it may permit passing a transmitter tested using 100 Hz RBW that failed when tested using 300 Hz RBW.

On page 3 of the Ericsson addendum, they proposed to "...use 100 Hz or less resolution bandwidth for measuring spectral emissions (rather than 300 Hz)." This was discussed in the TIA TR 8.1 Measurement Methods committee meeting held on March 14, 1993, and the participants (including Ericsson) agreed that measurement flexibility could be accommodated without allowing additional adjacent channel interference as long as the mask were adjusted for use of a resolution bandwidth (RBW) other than 300 Hz (since the TIA proposed mask was based on the use of 300 Hz RBW and the Ericsson modified mask was based on the use of 100 Hz RBW).

Figure 1 is provided to clarify the effect on emission measurement of the choice of RBW. Of the 2 spectrogram traces in the Figure, it would appear that the lower one has more margin to the mask and provides more interference protection. This is an illusion as the same type accepted 9.6 kbps 4-level FSK (C4FM) transmitter noise-like type F1E/F1D emission was used to produce both traces on the same analog spectrum analyzer. The only difference between the 2 traces is that 100 Hz RBW was used for the lower trace rather than 300 Hz which was used for the upper trace.

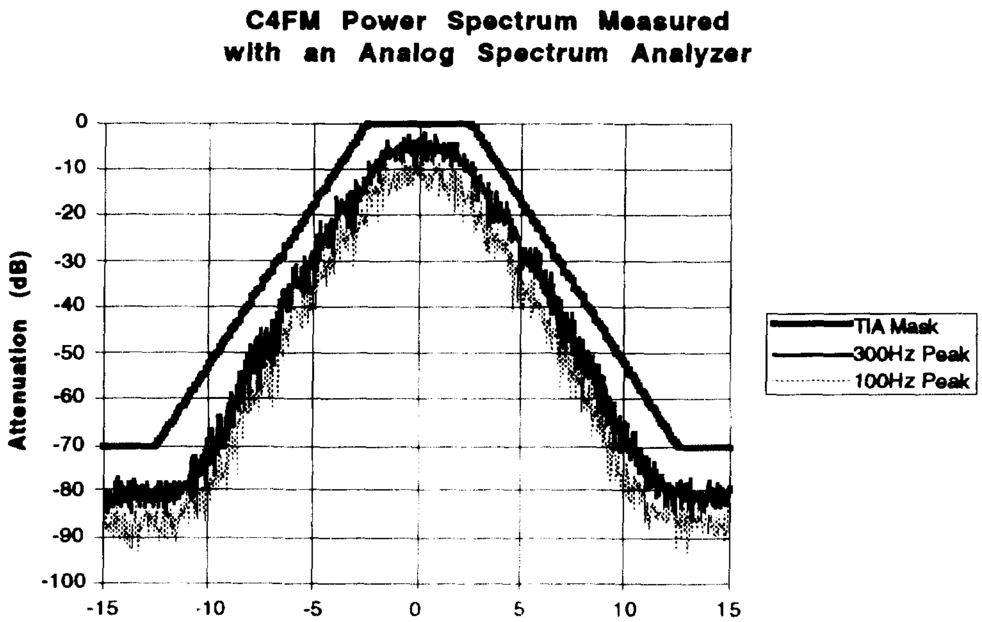

Fig. 1 - Effect of RBW on measurement of 9.6 kbps 4-level FSK(8K10F1E emission)

This illusion also occurs equally for other modulation choices. Figure 2 compares 100 Hz and 300 Hz RBW results for 9.6 kbps Pi/4 QPSK (CQPSK) type G1E/G1D emission. The 4.77 dB difference again is readily apparent.

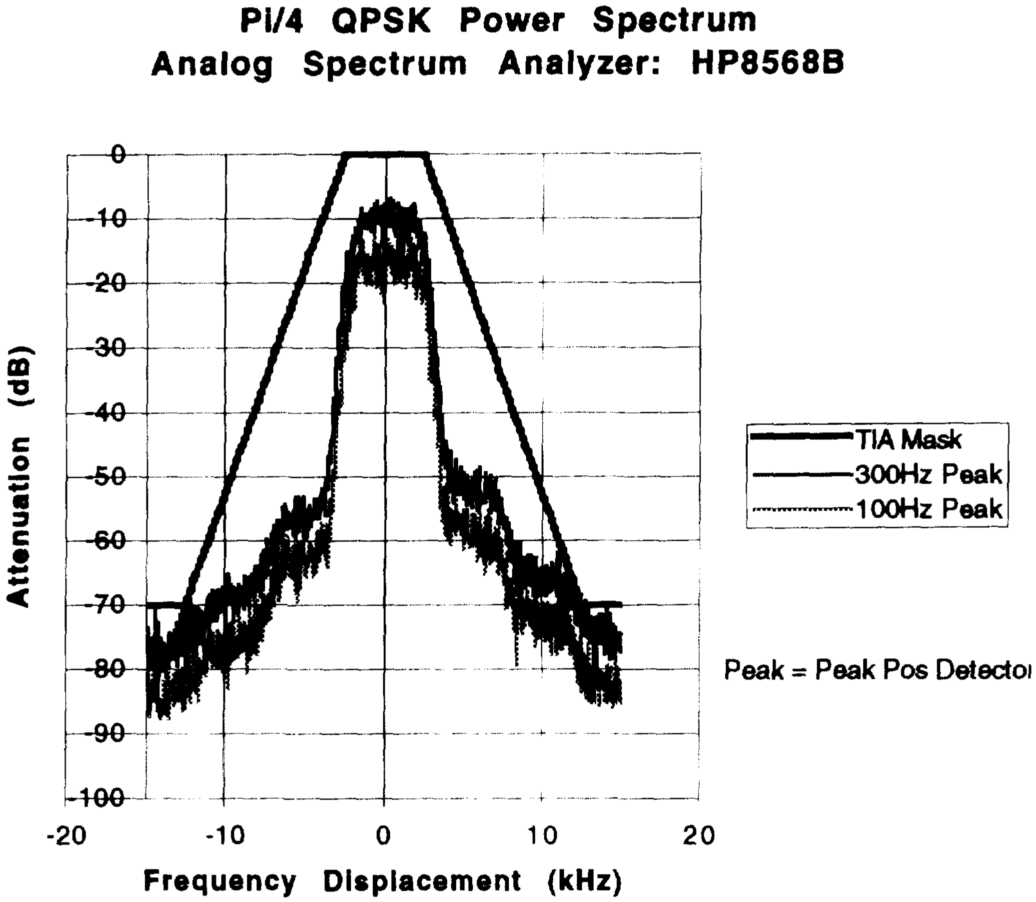

Fig. 2 - Effect of RBW on measurement of 9.6 kbps PI/4 QPSK(5K76G1E)

To preclude this liberal illusionary effect on an examiner, which does not occur when an emission is measured using a standard receiver on an adjacent channel, TIA conservatively restricted the spectrum analyzer measurement to the specific value of 300 Hz RBW.

Motorola recognizes that it may not be possible to use 300 Hz on certain modern spectrum analyzers which automatically adjust resolution bandwidth, and that a transmitter manufacturer may elect to use a different value. One solution to eliminate the illusion is to compensate the measured trace by adding 4.77 dB to lift each data point on the trace produced using 100 Hz RBW. The effect of this compensation is apparent in Figure 3 where the two traces are seen to be essentially congruent. Thus, the apparent interference margin to the control mask remains the same between the 2 methods of measurement if the data is properly adjusted prior to FCC submission.

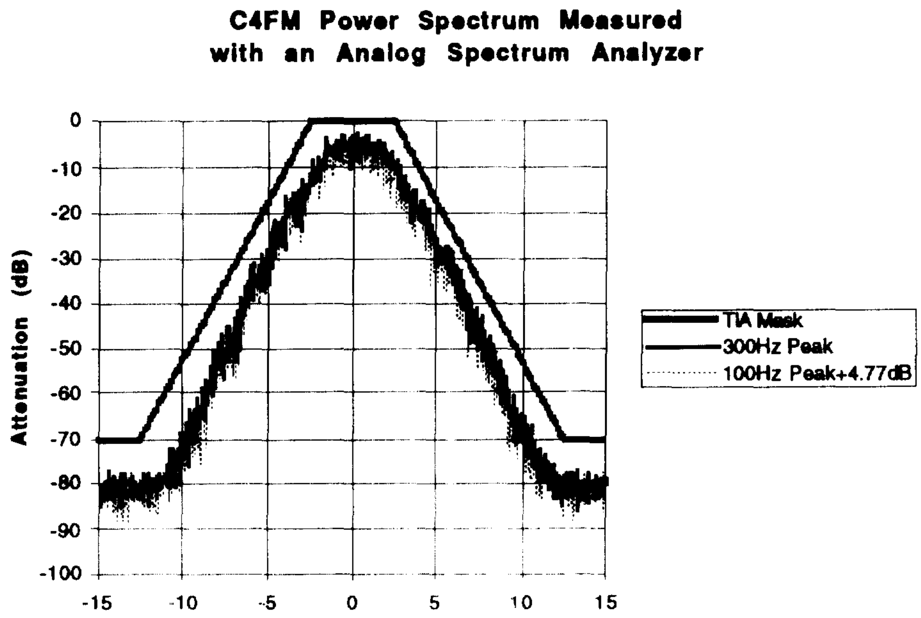

Fig. 3 - Comparison of RBW compensated trace for 9.6 kbps 4-level FSK

An alternative solution is to compensate the mask for the RBW of the analyzer employed for the emission measurement to lower it for values of RBW less than 300 Hz. This has the same effect as adding the proper correction factor to the data but, because it is less prone to operator error, this is Motorola's preference if the FCC were to adopt the Ericsson RBW proposal.

Motorola recommends that for the mask region where attenuation is specified to be other than zero, the emission mask attenuation formulation be modified to add the term $+10\log_{10}(300/RBW)$, where RBW is the resolution bandwidth in Hz, for the masks proposed in FCC docket 92-235 parts 88.421 other than that proposed for the 216-222 MHz band which was originally based on a 100 Hz RBW.

Figure 4 is provided to compare at 100 watts output power a 100 Hz resolution bandwidth compensated mask for comparison to the 300 Hz mask. Note that the compensation to the mask introduces a small 4.77 dB "top hat" profile in the center region and the occupied bandwidth narrows. At the channel edges and further, the mask is lowered 4.77 dB to correct for the illusion, thus permitting correct assessment of interference margin to the emission control mask.

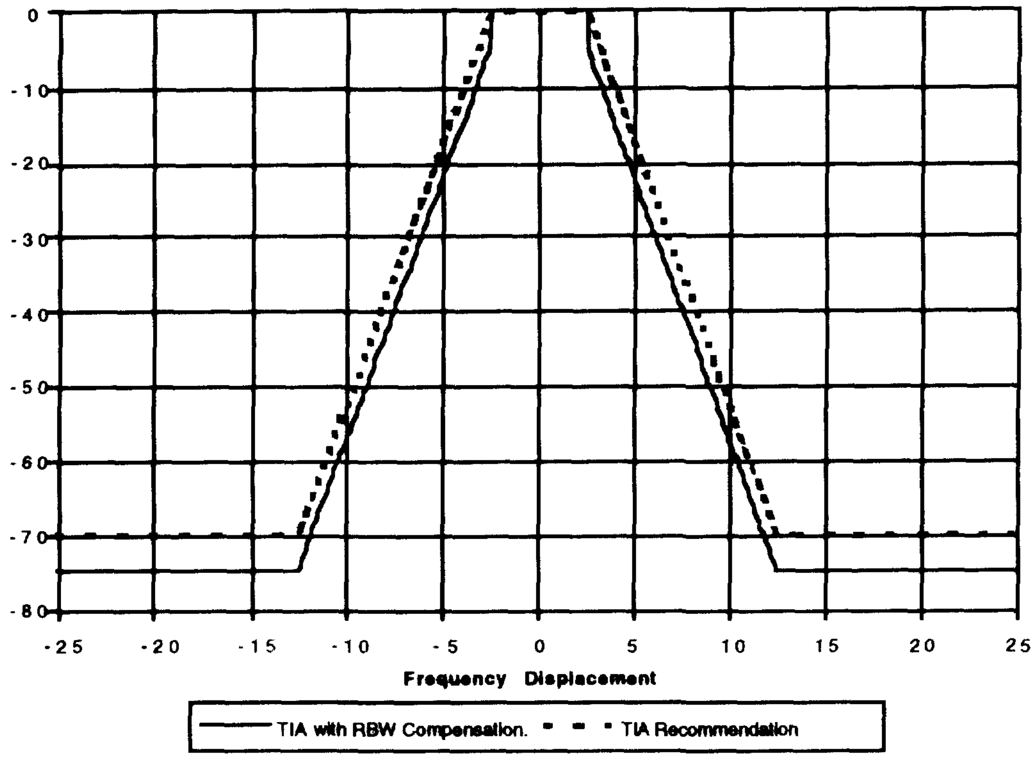

Fig. 4 - RBW compensated mask comparison with uncompensated mask

1.2 RMS Average measurements using an FFT based spectrum analyzer

An FFT based analyzer such as the Hewlett Packard 89441A can provide several different types of displays. The Continuous Peak Hold (CPH) display mode provides a spectrogram result for a noise-like emission which is the equivalent of the result obtained using a Peak Detector on an analog type analyzer (such as the HP 8568B used for Figures 1 to 4). Another option is the Video average mode which calculates the RMS Average of multiple repetitions of the signal, with 50 being a commonly used number of repetitions.

On page 4 of the addendum, it was stated that "...Ericsson strongly recommends adopting average detection as an option for measuring spectral emissions" citing the use of "... FFT-based analyzers...". Their recommendation fails to note that there is a 6.5 dB difference in measurement that results when measuring Gaussian noise like emissions between peak and average measurement (ref. - *Hewlett Packard Application Note 63C*). Like the resolution bandwidth discussion, this difference is liberal in that the use of RMS average display may pass a transmitter tested using the CPH mode.

Figure 5 is provided to clarify that difference truly exists and the same illusion of additional interference margin occurs when performing an emission measurement with RMS average. Figure 5 is the same emission used for Figure 1, and the upper trace therein produces the same result as the upper trace in Figure 1. The lower trace in Figure 5 appears to have more margin to the mask and provides more interference protection. However, this is an illusion as the same APCO Project

25 transmitter noise-like emission was used to produce both traces on a Hewlett Packard model 89441A FFT based spectrum analyzer. The only difference is that RMS average display mode was used for the lower trace rather than CPH mode which was used for the upper trace.

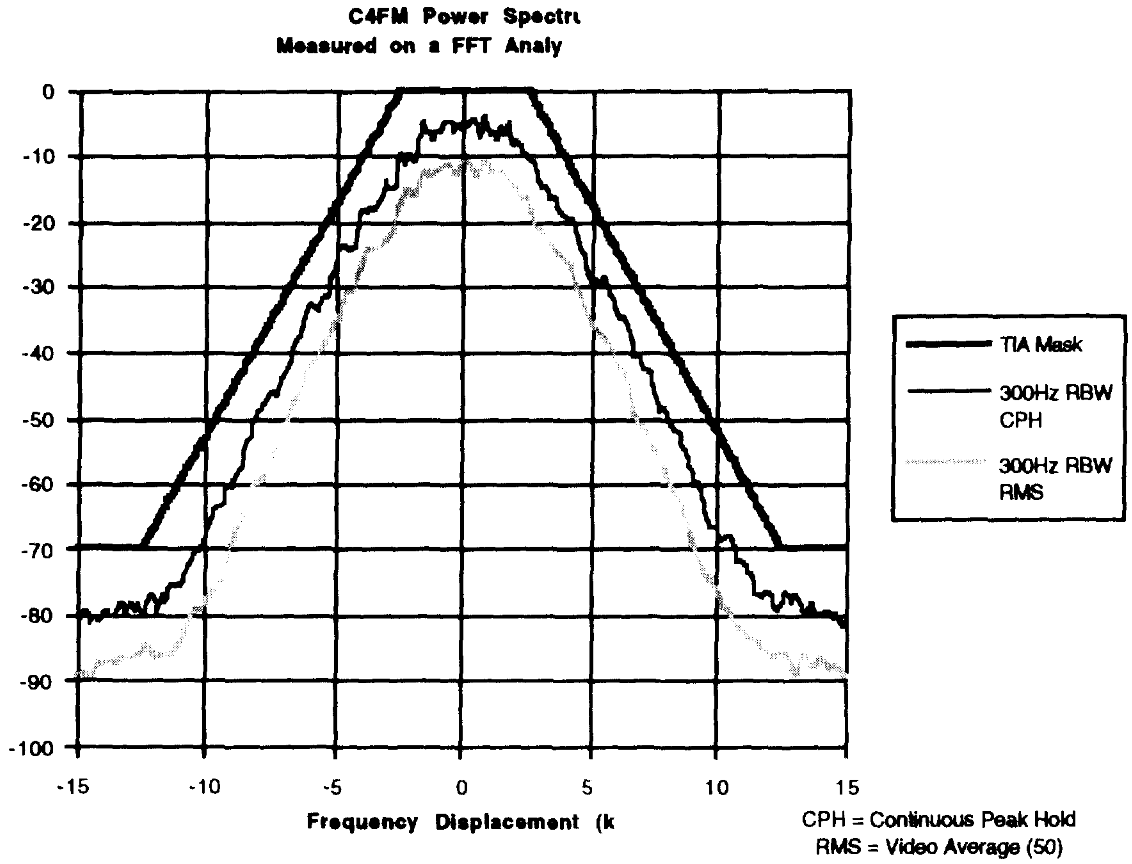

Fig. 5 - Effect of display mode on 9.6 kbps 4-level FSK emission measurement

One solution to eliminate this illusion is to compensate the trace measured using the RMS Averaging display mode by adding 6.5 dB to lift each data point. The effect of this compensation is illustrated in Figure 6 where the two traces are seen to be nearly congruent. This way the apparent interference margin to the control mask remains the same.

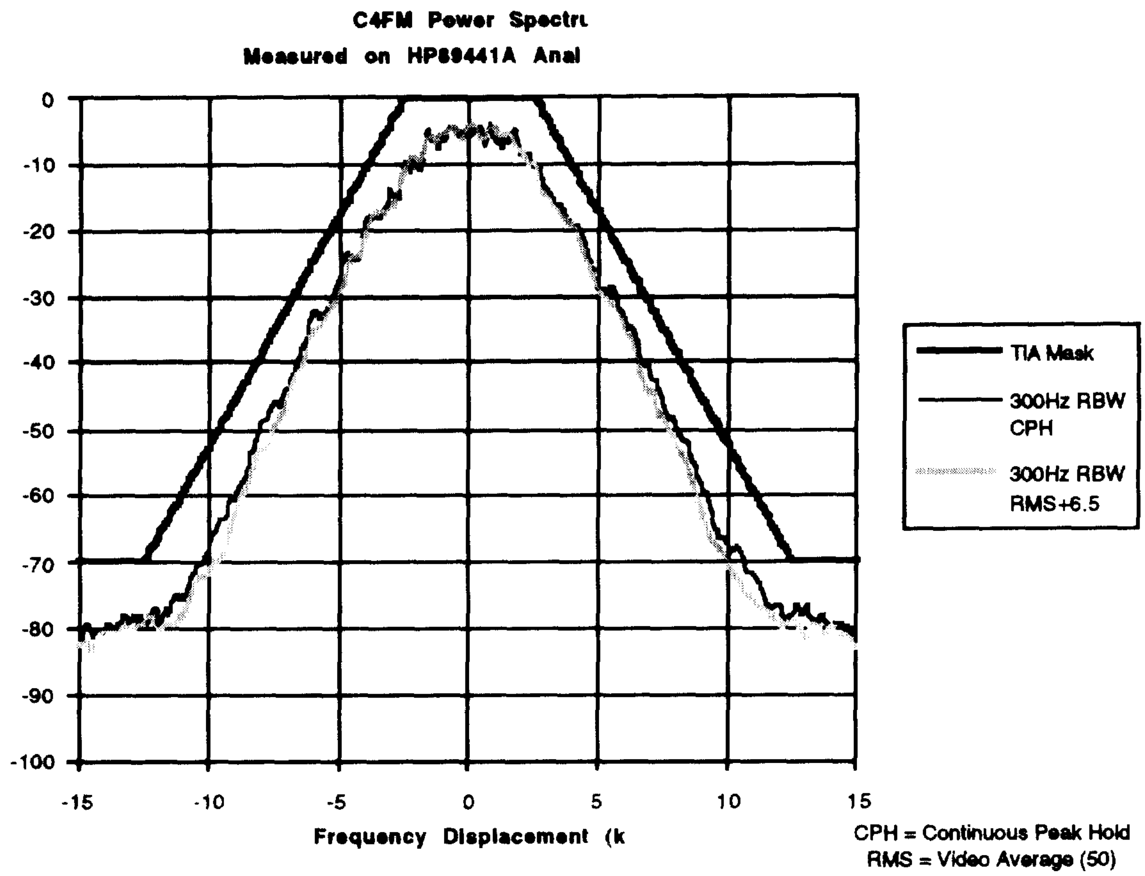

Fig. 6 - RMS Average measurement compensated trace for 9.6 kbps 4-level FSK

An alternative solution is to compensate the mask for the type of analyzer measurement employed by lowering the mask when an RMS Average is utilized. Motorola considers this more practical and is it's preference if the F.C.C. were to accommodate Ericsson's recommendation of the optional use of an FFT based analyzer using average detection. Further, if this Ericsson proposal is accepted for the masks proposed in FCC docket 92-235 parts 88.421, then Motorola recommends that for the mask region where attenuation is specified to be other than zero, the emission mask attenuation formulation be modified to add the term +6.5 dB when this option is used.

Figure 7 is provided to compare an RMS average measurement compensated mask to the mask proposed for use with peak detection measurement. Note that this introduces a 6.5 dB "top hat" profile in the center region, and narrows the occupied bandwidth (as observed at the 20dB attenuation level). At the channel edges and greater displacement, the mask is lowered 6.5 dB to correct for the visual illusion, thus correctly permitting assessment of interference margin to the emission control mask.

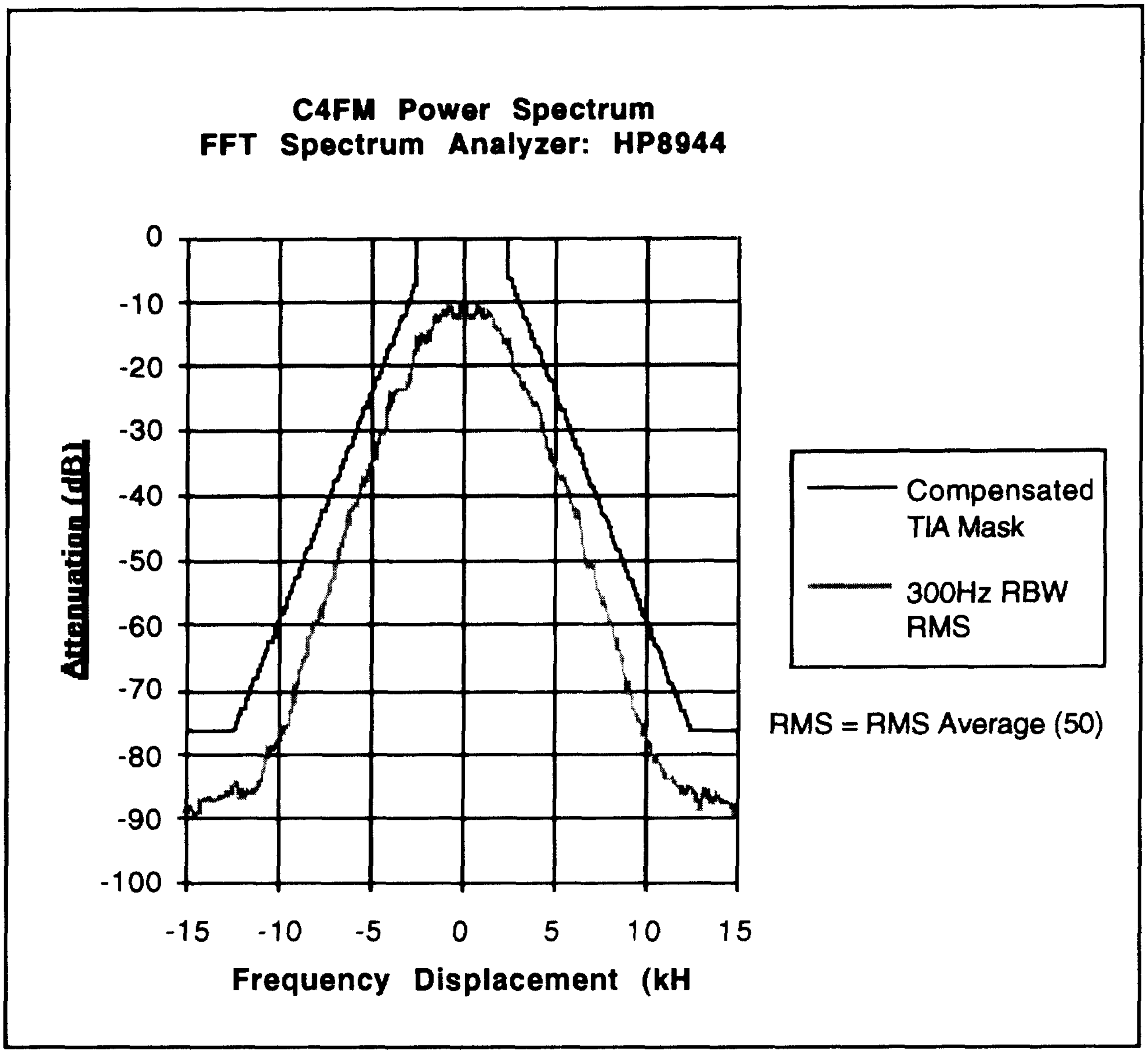

Fig. 7 - RMS Average measurement with mask compensation for 9.6 kbps 4-level FSK

2. Adaptive measurement method compensated TIA recommended 12.5 kHz emission mask

Motorola is concerned that the Ericsson proposed mask does not provide any consideration of the liberal illusion these 2 measurement method differences produce which will lead to tolerating an increase of interference of 4.77 + 6.53 = 11.3 dB compared to the TIA proposed conservative measurement method. This is 13.5 times
more interference power which will lead to degraded service, and lower spectrum utilization in spite of the claim that it offers 2 for 1.

To permit the use of the measurement equipment and settings advocated by Ericsson and yet not permit the occurrence of interference potential greater than that recommended by TIA in its proposal of May 28, 1993, Motorola recommends the FCC adopt the following adaptive measurement method compensated TIA recommended mask:

The power of any emission component shall be attenuated below the unmodulated transmitter output power in accordance with the table below:

Frequency displacement (kHz)	Minimum attenuation (dB)	Display mode
0.0 < f_d < 2.5	0	
2.5 £ f_d < 12.5	7 x (f_d - 2.5) + 10 $\log_{10}$(300/RBW); or 7 x (f_d - 2.5) + 10 $\log_{10}$(300/RBW) + 6.5	Peak; or RMS Avg.
12.5 £ f_d < 50.0	70 + 10 $\log_{10}$(300/RBW), or 50 + 10 $\log_{10}$(RFOP), whichever is less; or 70 + 10 $\log_{10}$(300/RBW) + 6.5, or 50 + 10 $\log_{10}$(RFOP) + 6.5, whichever is less.	Peak; or RMS Avg.

Note 1: RFOP is Radio Frequency Output Power
Note 2: RBW is the measurement resolution bandwidth and is £ 300 Hz
Note 3: Displacement Frequency (f_d) is the magnitude (in kHz) of the difference between the operating frequency and the emission component frequency.

Figure 8 is provided to compare the adaptive TIA mask that would result using Ericsson's proposed 100 Hz RBW and peak detection measurement method and measurement methods with the TIA mask using the traditional TIA recommended 300 Hz RBW and peak detection. Note that this adaptive mask formulation introduces an 11 dB "top hat" in the center; and 11 dB more attenuation along the skirt and the floor to compensate for the illusionary margin that can occur.

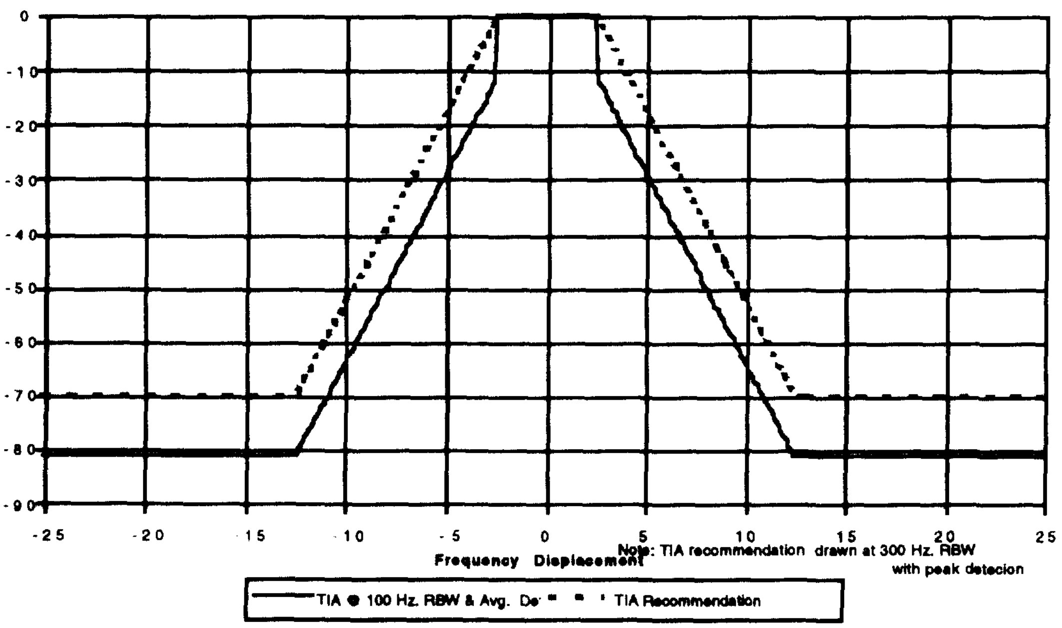

Fig. 8 - Uncompensated and adaptive TIA emission mask comparisons

Using the formulation provided by Ericsson for the modified mask in their addendum, a graph was contstructed in Figure 9 that compares it to the adaptive TIA mask when using the Ericsson measurement methods of 100 Hz RBW and RMS average detection. The greater adjacent channel interference it would permit is readily apparent.

Figure 10 is provided to show how the modified Ericsson mask would compare with the TIA mask after being compensated for the measurement differences between Ericsson's and TIA's recommended measurement methods (300 Hz RBW and peak detection).

Both Figures 9 and 10 compare the Ericsson mask and the TIA mask on a comparable basis, with Figure 9 being the traditional way that has been used for 25 kHz spacing under standard TIA/EIA-603, and Figure 10 using Ericsson's proposed method of measurement. As evident in Figure 10, applying compensation to the Ericsson modified mask serves to reduce the step associated with the Ericsson "top hat" resulting in an occupied bandwidth (at the 20 dB attenuation level) of 16 kHz when measured the traditional way. This exceeds the channel spacing, and is considerably more than the 11.3 kHz occupied bandwidth that results with the top hat if the step size is 20 dB or more as occurs when measured with the Ericsson proposed method. Note that these differences are independent of the emission type.

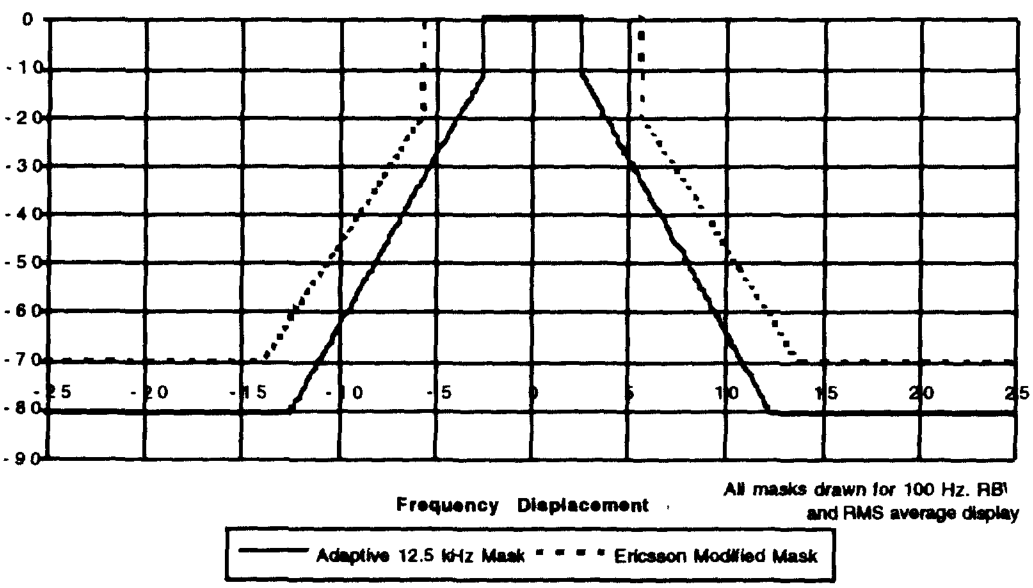

Figure 9 - Comparison of Ericsson modified mask with Adaptive TIA mask

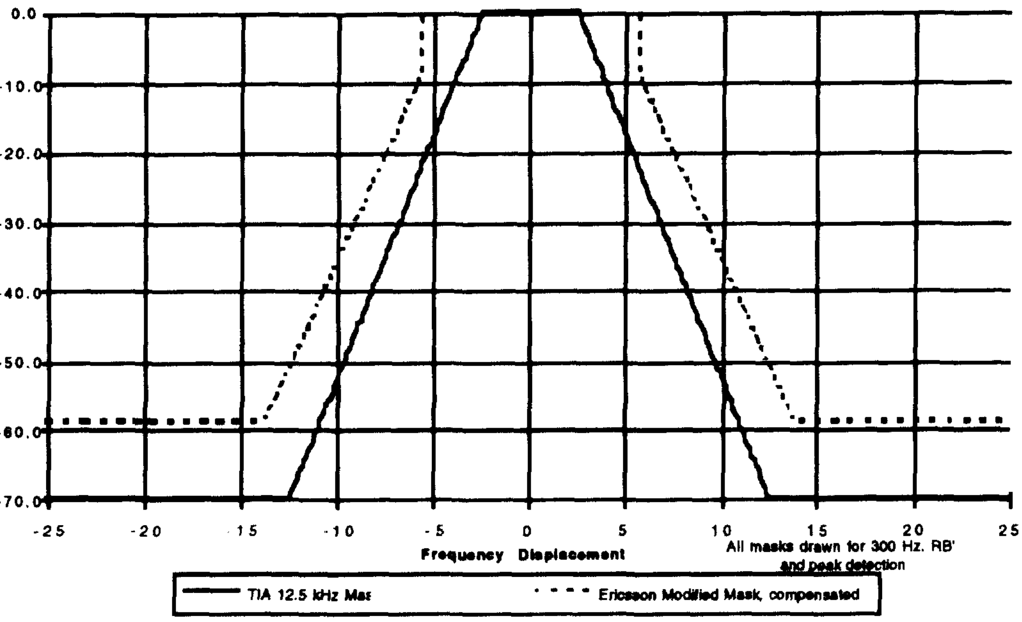

Figure 10 - Comparison of Ericsson modified mask with Adaptive TIA mask

3. Adjacent channel interference control and spectrum pollution

One common means of determining the adjacent channel interference potential is to determine the amount of attenuation provided at the channel edge. From the formulations, the TIA recommended mask is calculated to be 7 x (6.25-2.5) = 26.3 dB and the Ericsson modified proposed mask using the Ericsson proposed measurement methods is calculated to be 6.15 x (6.25-2.4) = 23.7 dB.

Mathematically, the mask formulation difference is 2.6 dB and appears to be the difference in interference potential between them. But these mask numerical formulations do not take into account measurement method differences. This apparent 2.6 dB mask formulation difference needs to be compensated for the difference in the measurement methods proposed by Ericsson for use with their mask; namely 4.77 dB for the lower resolution bandwith and 6.53 dB for the use of an RMS average display. It is readily seen that the 11.3 dB measurement method difference is the dominant difference, and in fact leads to a interference potential diffence of nearly 14 dB, not circa 3 dB. This is evident in Figure 10 where the Ericsson mask is seen to provide only 12.4 dB attenuation at the channel edge compared to the 26 dB provided by the TIA mask.

In contrast to these proposals to the F.C.C., in its comments to the TIA on the letter ballot for TSB102.CAAB (TR 8.6/94-06-0002), Ericsson objected to that document stating "We would recommend that digital adjacent channel protection be specified in the range 70 dB for mobiles and 80 dB for base stations, at minimum." Since these levels were greater than those adopted by TIA, there seems to be a contradiction in their positions as their proposals to the F.C.C. will provide even less interference protection than TIA recommended.

Since Ericsson has publicly stated their EDACS/PRISM FTDMA products meet the TIA proposed mask, there seems to be no need for their proposed new mask. In view of the liberal treatment sought in their proposed methods of measurement for sideband emissions, concern is expressed herein that the Ericsson proposed masks and methods of measurement are intended to justify a significantly increased level of interference compared to the TIA recommendations. The reason is unclear; it could be to justify a lower cost grade of transmitter amplifiers, or to support a future higher bit rate using less spectrally efficient modulation rather than using a new modulation method or limiting the bit rate to fit the available bandwidth with their currently chosen form. Regardless of the reason, it appears the primary effect of the Ericsson proposed mask and measurement methods will be to permit significantly greater spectrum pollution whcih can only serve to degrade the future grade of service in the affected frequency bands.

Another means of assessing interference potential is to measure the adjacent channel power ratio. Motorola advocated in its March 1995 comments to the F.C.C. that part 88 adopt an additional requirement for a transmitter to meet adjacent channel power ratio

(ACPR) specifications to serve in conjunction with a mask for interference control. TIA has limits for ACPR defined in TIA/EIA-603 clause 3.2.14 et. al., and TSB102.CAAB clause 3.2.8, when respectively measured as stated in TIE/EIA-603 clause 2.2.14 and clause TSB102.CAAA clause 2.2.8. Ericsson has not disclosed the resulting ACPR measured using TIA recommended methods for a modulation format that requires their proposed mask.

4 Occupied Bandwidth considerations

Ericsson's 12.5 kHz mask proposal defines a 5.625 kHz wide 0 dB attenuation center section in the mask which would effectively define an occupied bandwidth of 11.3 kHz. In its March reply Motorola recommended a maximum authorized bandwidth of 10.4 kHz based on F3E emission.

TSB102.CAAB has recommended a frequency tolerance of 2 PPM for the UHF band below 512 MHz which corresponds to an allowable transmitter frequency drift of 1 kHz. This was established as an economic point of diminishing returns. Since the receiver on an adjacent channel may have the same amount of drift, the relative spacing between a transmitter and an adjacent channel receiver with a comparable bandwidth operating within specifications may be only 12.5 - 2 = 10.5 kHz. The occupied bandwidth tolerated in the Ericsson proposal exceeds this amount. This in turn means interference will occur unless frequency stability is improved twofold, which Ericsson has not proposed. This overlap will not occur with the Motorola recommendation of 10.4 kHz and the TIA recommeded frequency stabilty. Thus, the Ericsson proposed "top hat" width seems excessive.

Motorola, and others at the March 14th TIA TR 8.6 committee meeting, concurred with Ericsson that a wider "top hat" center section in the mask adds flexibility, and it can be tolerated in the TIA mask without harmful interference.

In consideration of F3E emission and frequency stabilty discussion above, it is recommended that the adaptive TIA mask be broadened to 0 dB attenuation for any frequency displacement up to a corner frequency equal to half of the maximum authorized bandwidth (10.4/2 = 5.2 kHz). With the exception of the corner frequency of 5.2 kHz rather than 5.625 kHz and the adaptive features, this proposal is identical to Ericsson's proposed modification to TSB102.CAAB clause 3.2.5.2 which they included as part of their May 24, 1994 negative ballot on TSB102.CAAB to the TR 8.6 committee. The following table formulates this broader adaptive mask which Motorola herein proposes the FCC adopt for part 88.

Motorola recommends the power of any emission component shall be attenuated below the unmodulated transmitter output power in accordance with the table below:

Frequency displacement (kHz)	Minimum attenuation (dB)	Display type
$0.0 < f_d < AB/2$	0	
$AB/2$ £ $f_d < 12.5$	$7 \times (f_d - 2.5) + 10 \log_{10}(300/RBW)$; or $7 \times (f_d - 2.5) + 10 \log_{10}(300/RBW) + 6.5$	Peak; or RMS Avg.
12.5 £ $f_d < 50.0$	$70 + 10 \log_{10}(300/RBW)$, or $50 + 10 \log_{10}(RFOP)$, whichever is less; or $70 + 10 \log_{10}(300/RBW) + 6.5$, or $50 + 10 \log_{10}(RFOP) + 6.5$, whichever is less.	Peak; or RMS Avg.

Note 1: RFOP is Radio Frequency Output Power
Note 2: RBW is the measurement resolution bandwidth and is £ 300 Hz
Note 3: Displacement Frequency (f_d) is the magnitude (in kHz) of the difference between the operating frequency and the emission component frequency.
Note 4: AB is the Authorized Bandwidth and is £ 10.4 kHz.

Figure 11 is provided to illustrate the comparative appearance of this mask with the TIA mask and the Ericsson mask when all are drawn equalized for measurement using 300 Hz RBW and peak detection per TIA recommended measurement methods. This diagram is an extension of Figure 10 which graphically adds a 10.4 kHz wide "top hat" to the adaptive TIA mask.

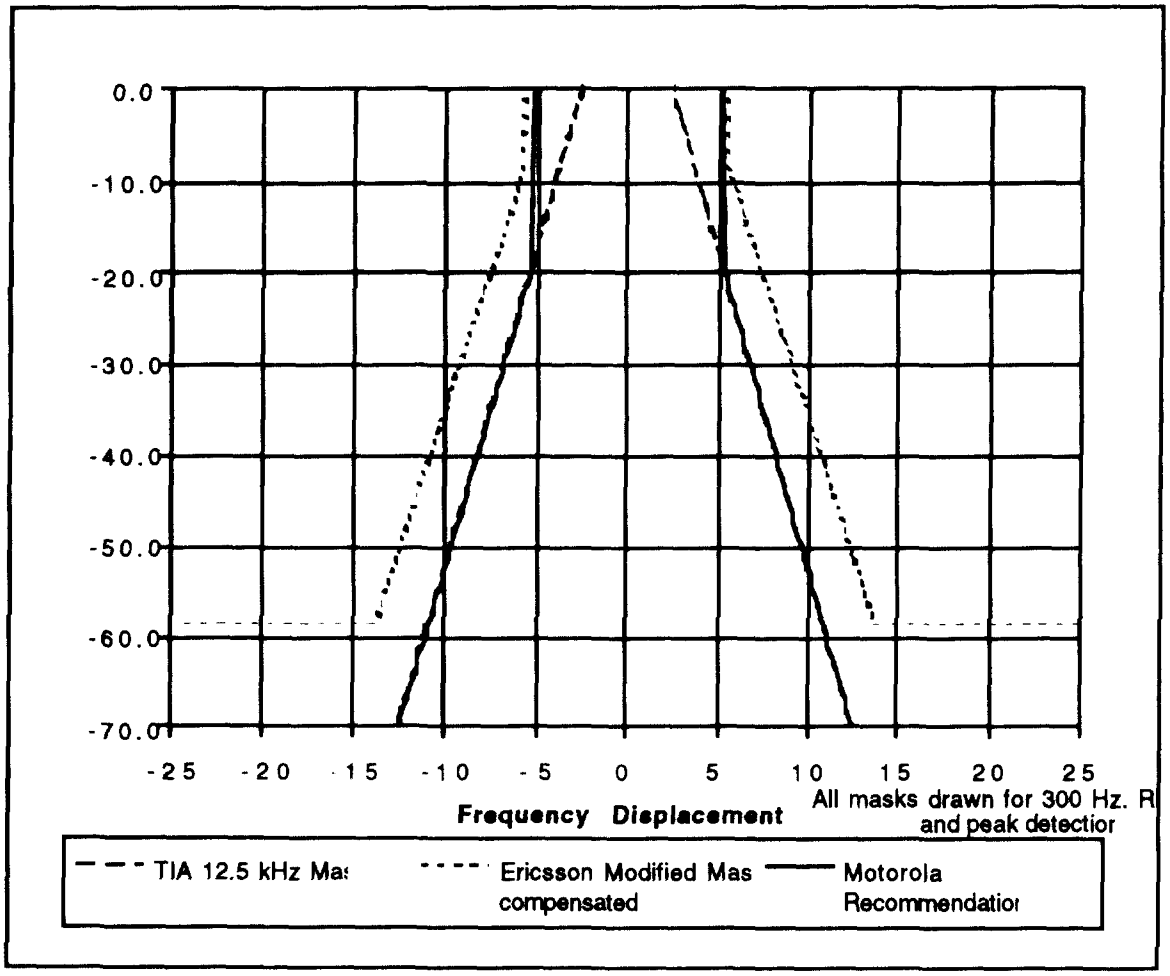

Figure 11 - Motorola recommended mask comparisons